Final Comprehensive Written Report for

"PEARS - Project Expense, Analysis and Reporting System" Web-Based Dashboard and Database Application

In Partial Fulfillment of the Requirements in

IE 271: Information Systems Engineering

Department of Industrial Engineering and Operations Research

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I.   Introduction

1. Background of the Project

Effective financial management which involves the proper allocation and monitoring of project finances, is integral to successful construction project management. According to *Peterson (2020),* financial management in construction involves utilizing a company's financial resources and encompasses all decisions that impact the company's financial health. He highlights how a good financial management can be the difference between a marginally profitable and a highly profitable project.

Additionally, timely reporting of monthly financial status is crucial in providing insights into budget status, profit margin forecasting, identifying the need for change orders, and managing project risks. This includes details such as item quantities and completion percentages to date, costs incurred to date, estimated remaining costs to complete, and the total estimated cost at project completion.

Now focusing to cost, as defined by *Wiley and Sons (2008)*, includes expenditures incurred in the day-to-day operations of a project. It encompasses overhead costs like mobilization, permits, staff salaries, and safety requirements, as well as direct costs covering materials, equipment, labor, and contingencies. These more or less show the huge amount of data that needed to be analyzed in order to create a healthy monitoring and control of a project finances, such that using a simple spreadsheet can be challenging due to the volume and variety of data from accounting reports, bills, and purchase orders. While there are popular software tools available, such as *Oracle Project Management* [1], which offers various automated tasks and features, its cost (approximately $275 or PHP 15,000 per month) may not be justifiable for small-scale projects and companies.

2. Problem Statement

Small construction projects and companies often face challenges in effectively managing project finances due to the complexity of data and cost of existing software solutions. Manual methods, such as using spreadsheets, are cumbersome and error-prone. There is a need for a cost-effective solution that can streamline financial management for smaller projects and companies, providing them with tools to better allocate and monitor project finances.

3. Project Objectives

To address the issue of streamlining financial management for smaller projects and companies, this project aims to develop a simple cost-control web-based application named Project Expense, Analysis, and Reporting System (PEARS). Specifically, the project aims to:

1. Be able to create a database of multiple projects with complete basic project details and contract profile;
2. Enable project-in-charge with assigned project(s) to formulate a budget and input and track monthly expenses; and,
3. Produce intuitive visuals and automated reports to facilitate better decision-making and ensure projects remain within budget, provide timely insights based on project budget and monthly expenses for project financial status which could aid project managers create informative decisions.

4. Scope and Limitations

The web-based application will be able to run locally on any simple computer machine but installation of PostgreSQL, a free and open-source relational database management system will be needed. In the additional to the use-case features that will be discussed in section *II.1*, the following will be the future features to work on and will serve as the current limitations of the application:

1. A more automated account registration which considers approval of managers for project-in-charge users;
2. An automated approval system before the deployment of the project budget in the system;
3. A formal process of transferring budget from one line-item to another;
4. A more detailed item categorization (i.e. separation of overhead and direct costs, specification of equipment, salary, material cost, etc.);
5. A detailed monthly progress-based consideration of item quantities for a more accurate forecasting (i.e. currently, distribution of each item budget will be divided only by the total number of months of the project duration rather than specifying the planned start and end duration in which the item will be used);
6. Addition of monthly cashflow and income of project for more commercial management insights; and,
7. Integration of machine learning algorithm to create a more accurate time-series analysis of the expenses for an accurate forecasting.

II. Systems Analysis and Design

1. Use-cases, Functions and Implementation

The high-level overview of the application's process is presented in the following workflow diagram.
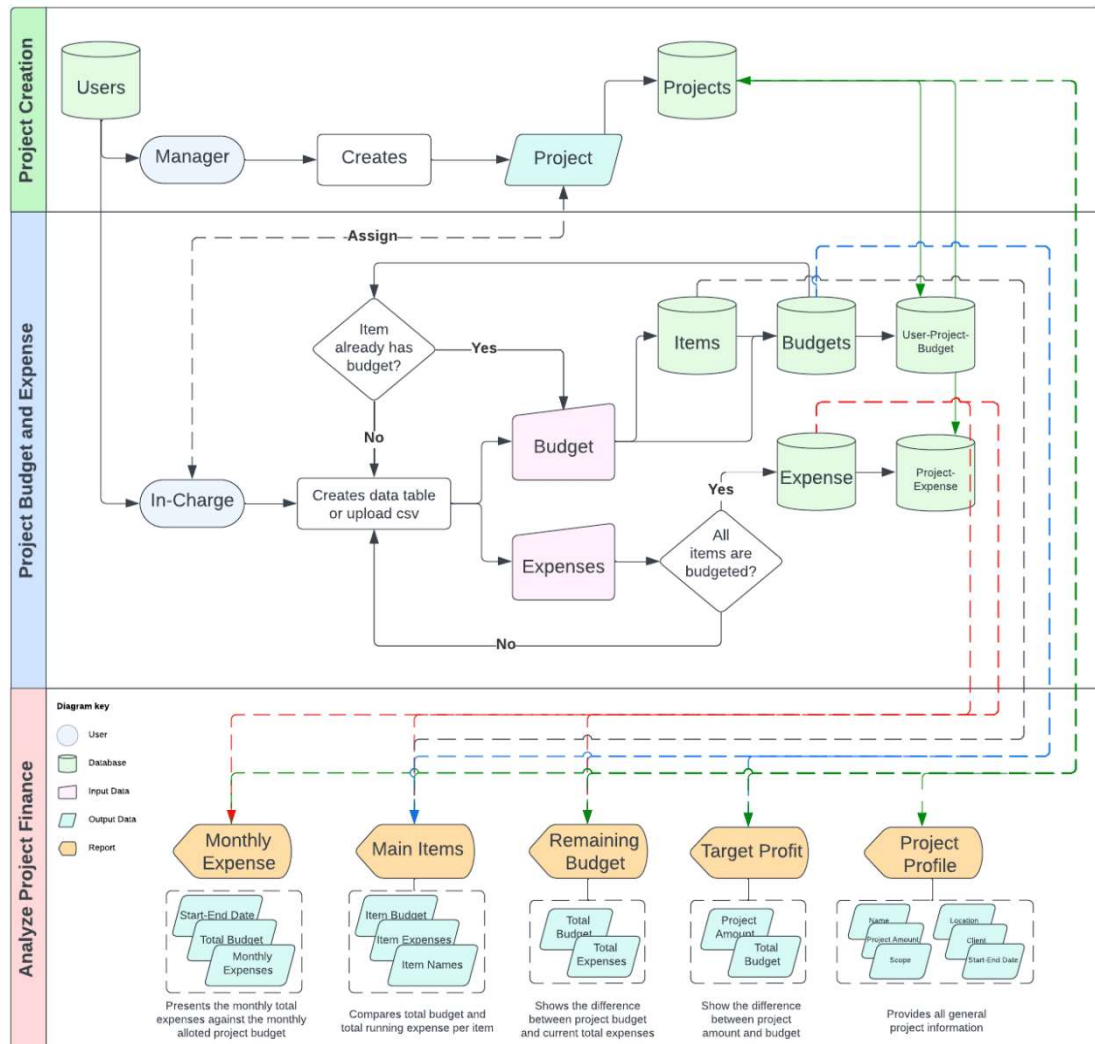

Figure 1. Workflow Diagram

Further details of the application's features and interface are in the following section. Based on the assigned role to the user, the user will be able to either perform as a ==*Top Management (TM)*== or ==*Project-In-Charge (PIC)*==. Within the app, these two types of account will have their own respective ability that they could perform and links they could access.

A. User Account and Log-In

Individual user will have their own respective user account to log-in on the application. Check **Attachment 1. Loggin-in as TM and PIC** for demo.

To control the number of accounts, the user ID and password for each user will setup by the application admin in order to limit the accounts for the app.
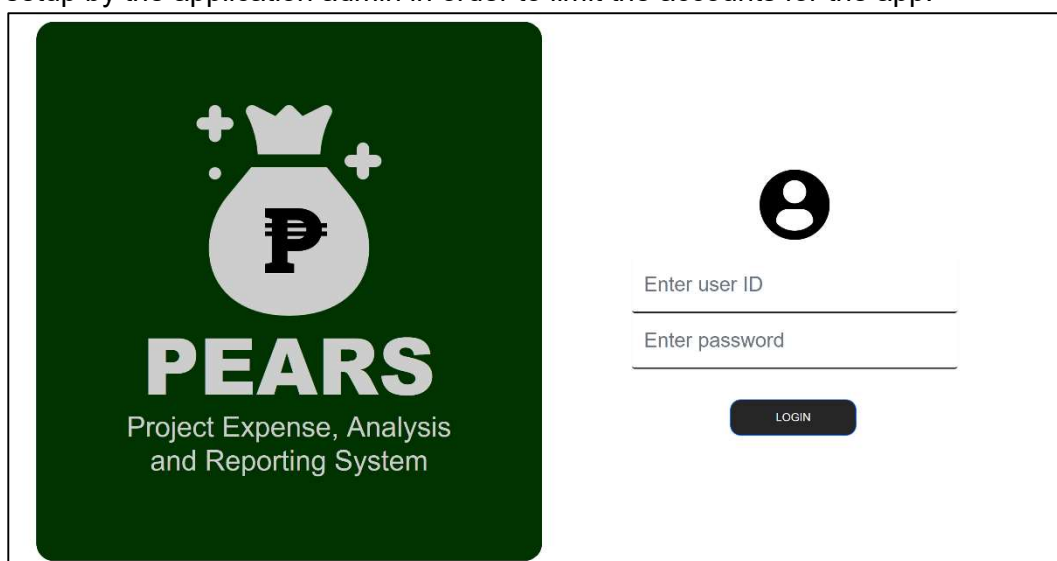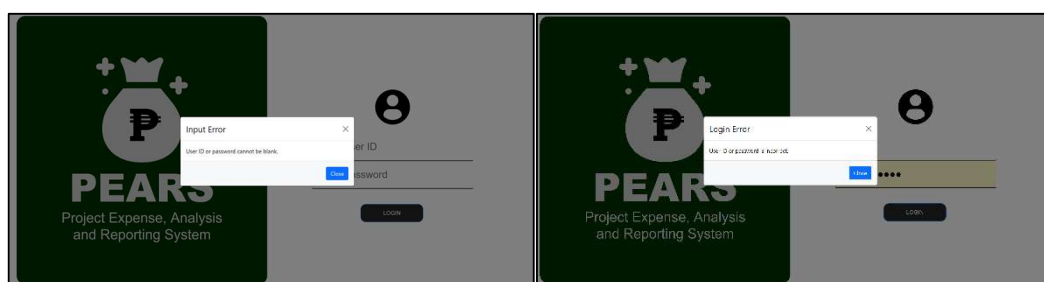

Figure 2. Log-in Page

Figure 3. Error for (a) blank user ID or password, and (b) incorrect inputs

	userid [PK] integer	password character varying (256)	user_type character varying (128)	user_del_ind boolean
1	240517	Password01	manager	false
2	240518	Password02	pj_ic	false
3	240519	Password03	pj_ic	false
4	240520	Password04	pj_ic	false

Figure 4. Sample pre-populated "Users" table database

After logging it, users will be directed on the following homepage providing details on the report that will be generated and how to use the application
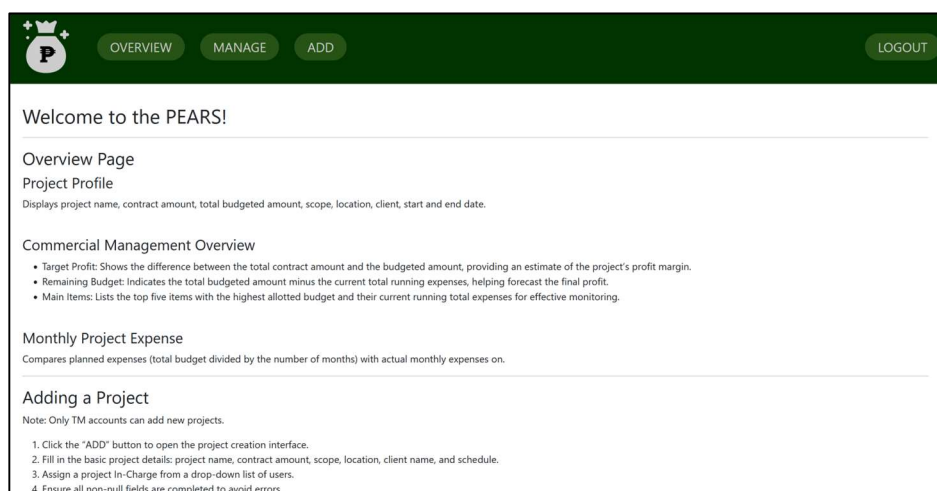

Figure 5. Application homepage which provides general information of the application

Additionally, respective user accounts will have the following navigation bar based on their account role.

(a)

(b)

Figure 6. (a) Navigation bar for TM and (b) PIC

B. Add New Project
The button, "ADD" for adding new project is only available for TM accounts. When this is clicked, the user will open the following interface. Demo presented at **Attachment 2. Adding Project.**

Figure 7. Interface for creating project

- Fill-up forms for basic project details such as project name, contract amount, short details for scope, location, client name, and schedule are available.
- The Manager also has to assign an "In-Charge" user to the project (*Figure 3.c.*), this In-Charge user will then have the access to the project details and have the ability to add project budget and expenses.

(a)

(b)

(c)

Figure 8. Features of the page:

(a) *Shows error when non-null data are empty (Project Name, Project In-charge, Amount, Schedule);*
(b) *Date-range selector for the schedule; and*
(c) *Drop-down list for users that are classified as "in-charge" in the pre-populated database.*

	projectid integer	projectname character varying (256)	userid integer	scope character varying (256)	location character varying (256)	client character varying (256)	amount numeric (15,2)	start_date date	end_date date	delet bool
1	24001	UPD-MenggAI-IE271-2324	240518	Database, SQL, Dashboard	Quezon City, Metro Manila	UP Diliman	75657871.88	2024-02-12	2024-06-15	false
2	24002	UPD-MenggAI-IE271-2324 #2	240519	Database, SQL, Dashboard	Quezon City, Metro Manila	UP Diliman	75657871.88	2024-02-12	2024-06-15	false
3	24003	UPD-MenggAI-IE271-2324 #3	240520	Database, SQL, Dashboard	Quezon City, Metro Manila	UP Diliman	75657871.88	2024-02-12	2024-06-15	false
4	24004	UPD-MenggAI-IE271-2324 #4	240520	Database, SQL, Dashboard	Quezon City, Metro Manila	UP Diliman	75657871.88	2024-02-12	2024-06-15	false

Figure 4. Sample database for "Projects" table

Notes:

- *Project ID is a 5-digit number automatically generated by the system; takes the form of YYXXX (last two digit of the year then three-digit number starting from 001)*
- *A project In-charge ID can be assigned to multiple projects (to reflect the possibility of overwork and exploitation in this capitalist industry)*

C. Project Budget and Expense Management

➢ General Interface
- When an account has clicked the **"MANAGE"** tab from the navigation bar, they will open this page for adding project data, either a project budget or a set of expenses. Sample demo at **Attachment 3. Adding Project Budget and Expense.**
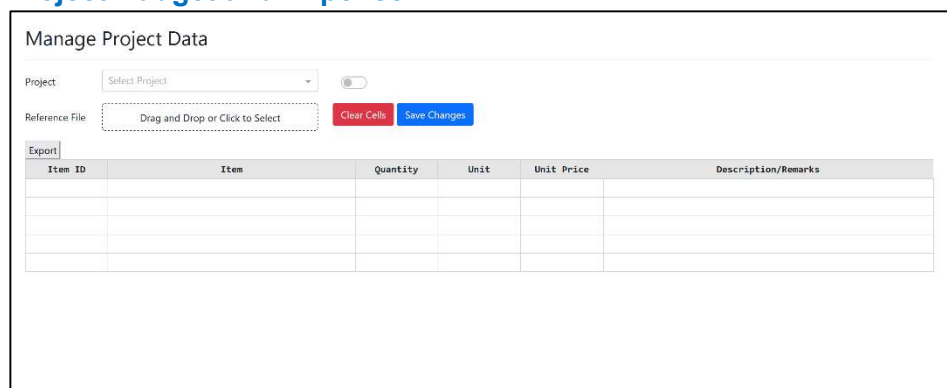
Figure 9. Interface for adding project data

- From the *Project Form,* the user will have the option to choose the available projects.
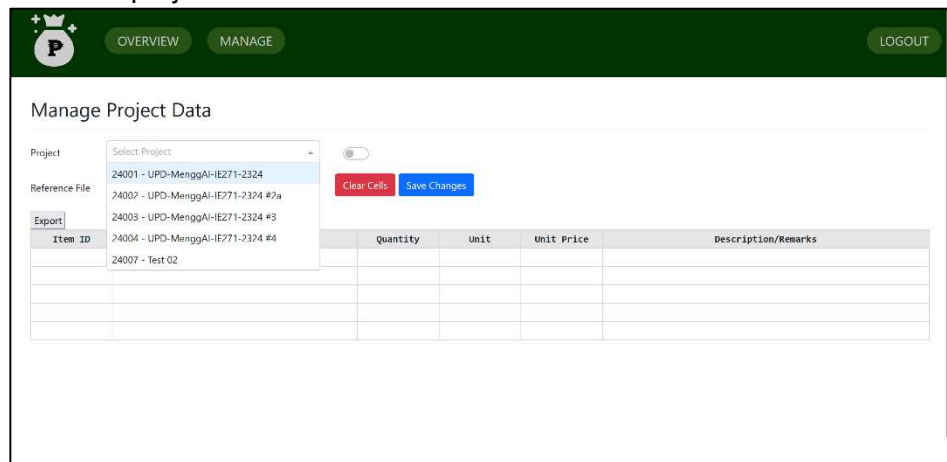
Figure 10. Choosing project to manage budget/expense data

- For TM account, they will have the access to edit data for all projects.
- For a PIC account, they will only be able to edit the project they were assigned to by the manager. An error indicating lack of access will show when they try to select a project that is assigned to them.
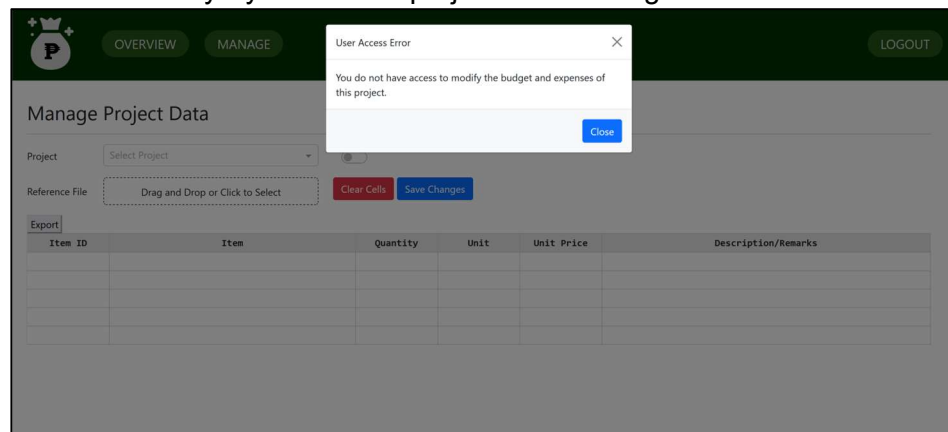
- Beside the project form, a toggle button for "Budget" and "Expense" is available, this will determine the mode the user is currently at.
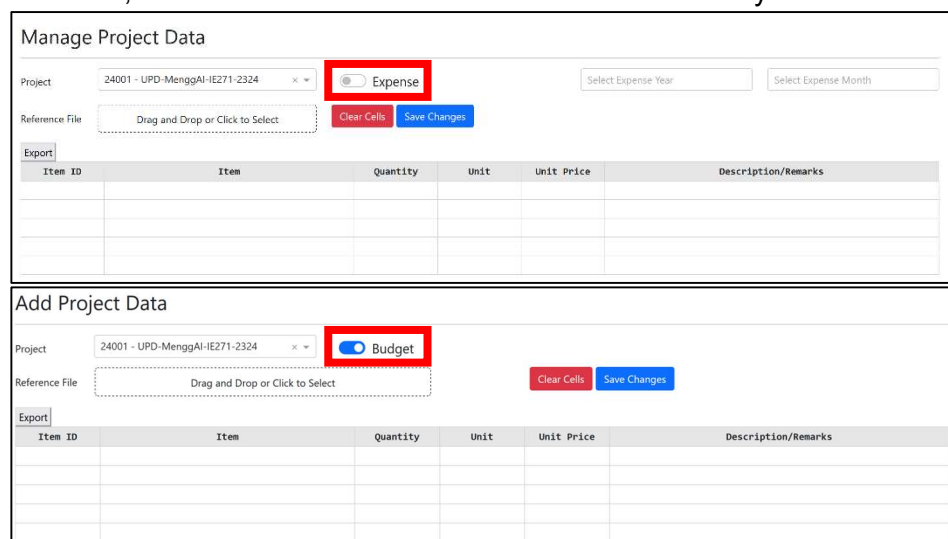

Figure 11. Switching between budget and expense mode

- A *Reference File* upload button is also available, so the user has the option to upload CSV files of the same table format as shown. Subsequently, table data could be exported and downloaded as csv file.
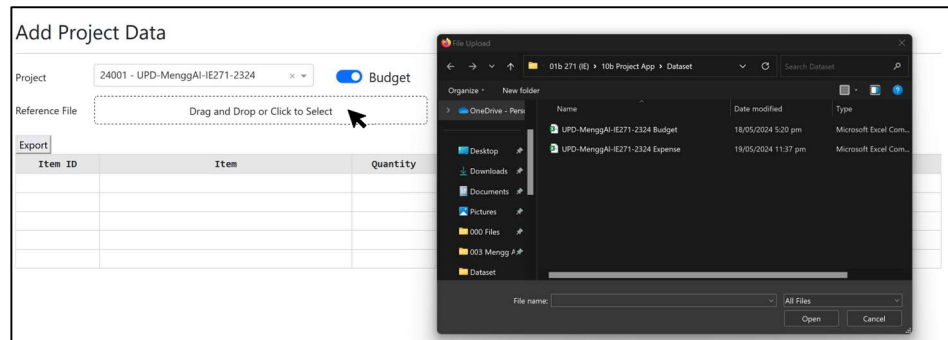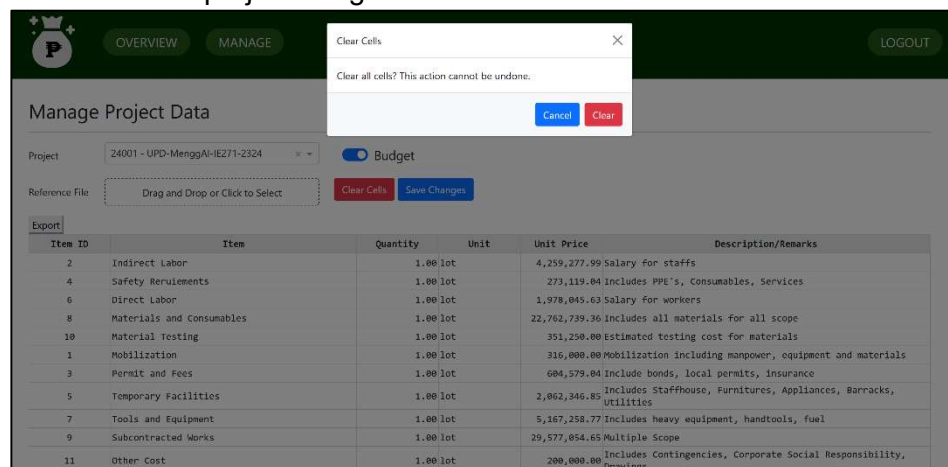
Figure 12. Uploading a CSV file

Figure 13. Sample uploaded budget data

➢ **Budget Mode:**

- Once a user has successfully filled up the table, or uploaded a csv file for the budget, they have the option to clear all table contents or save the data to the project budget.

(a)

(b)

Figure 14. (a) Clearing and (b) saving the table data to the database

(a)   *(b)*

Figure 15. Sample database for the "Budget" and "Items" tables:

> *(a) Budget ID is automatically generated based on the Project ID and takes the form "b-YYXXX" (adds a prefix "b-" to the Project ID for easy recognition, basically means "budget for project YYXXX)*
> *(b) Items database will take all the items across different projects. Item ID is also automatically generated via the "Serial" method in SQL. Perform checks whenever a budget is uploaded, if an item name already exist in the database, similar item ID is used, if new item ID is uploaded, assign a new item ID.*

- When the budget is successfully uploaded, the user would be able to automatically generate the project budget for easy viewing and modification by simply selecting the project and turning on the toggle for budget mode. (See ***Attachment 3a. Budget Mode – Viewing and Modifying***)

➢ **Expense Mode:**
  - During Expense Mode, a user could expense either also via the editing the table (highlighted in green), or uploading a CSV file similar to the budget mode.

Figure 16. Adding an expense

- Buttons for clearing cells and saving changes also function the same as well.

Figure 17. Successfully saved a project expense

Figure 18. Sample database for the "Expense" table

Expense ID is also an automatically generated ID based from the Budget ID which takes the form "b-YYXXX-XXX" or simply adds "-XXX" starting from -001 to the Budget ID. This enables the user to add multiply expenses to the project while emphasizing the source budget.
- *Item ID automatically matches the Item Name from the Item Database.*

- When an item name <u>not listed in the budget</u> is attempted to be saved in the database, an error will occur indicating the that expenses should be budgeted.
- This also add the constraint that the item name should perfectly match the names initially indicated in the budget. For example, Indirect Labor indicated in budget cannot be saved as Indirect in the expense.

Note: Dropdown list for the item names were added in the code but unfortunately do not show in the app likely due to bootstrap incompatibility.
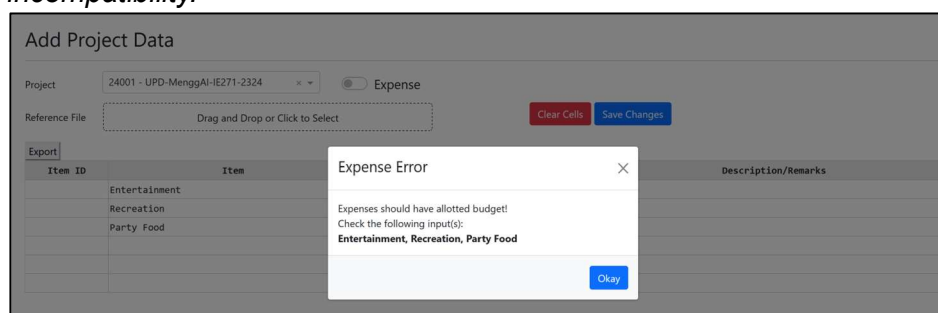

Figure 19. Sample error for adding unbudgeted items.

D. Project Dashboard and Reports Overview

Subsequently, based on the account type, the users will be able to access different set of reports. TM will be able to view reports for all projects and edit their basic profile. On the other hand, PIC will be able to view the details of the projects assigned to them. Page demo for this is shown in **Attachment 4. Project Overview and Editing a Project.**

a. **PROJECT PROFILE**

Displays project name, contract amount, total budgeted amount, scope, location, client, start and end date.

b. **COMMERCIAL MANAGEMENT OVERVIEW**

- Target Profit displays the difference of total contract amount and budgeted amount giving an estimate of the percent baseline for the project (i.e. Target Profit divided by contract amount provides the percent margin, which should be monitored monthly)
- Remaining Budget shows the total budgeted amount minus the current total running expenses. Useful for forecasting the total profit that will remain at the target end of the project based on the remaining works to be conducted and finished.
- Main Items presents the top five (5) items with highest allotted budget in the project, and their current running total expenses. Necessary to be monitored as these are the main driving force for managing the project profit and expense.

c. **MONTHLY PROJECT EXPENSE**

Compare planned expenses (*currently limited with total budget divided by total number of months based on the project duration, in the future, this should consider the actual project schedule generated from Gantt chart*) with actual expenses on a monthly basis.
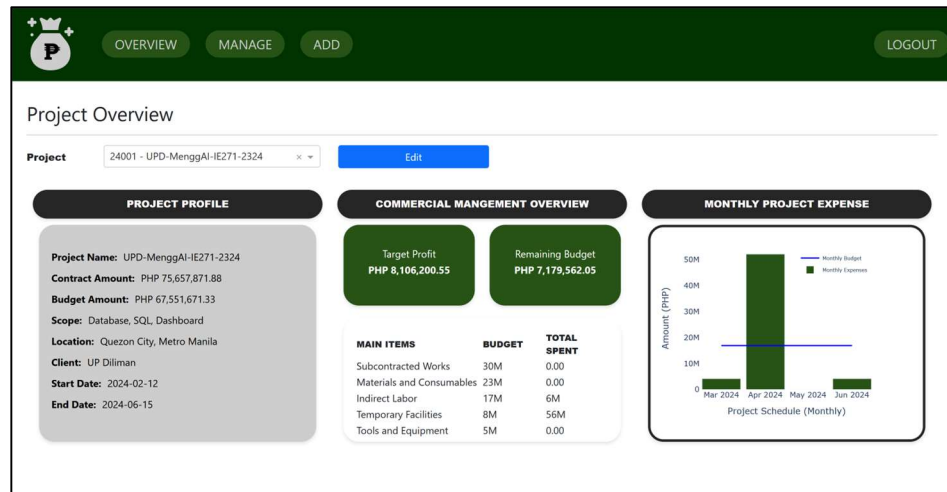
Figure 20. Interface of a TM with sample generated report for a project

Figure 21. Page for editing a project when a TM click the edit button

Figure 22. Interface for a PIC account which does not include the edit button and has limited number of projects in the drop-down list

2. Entity-Relationship Diagram
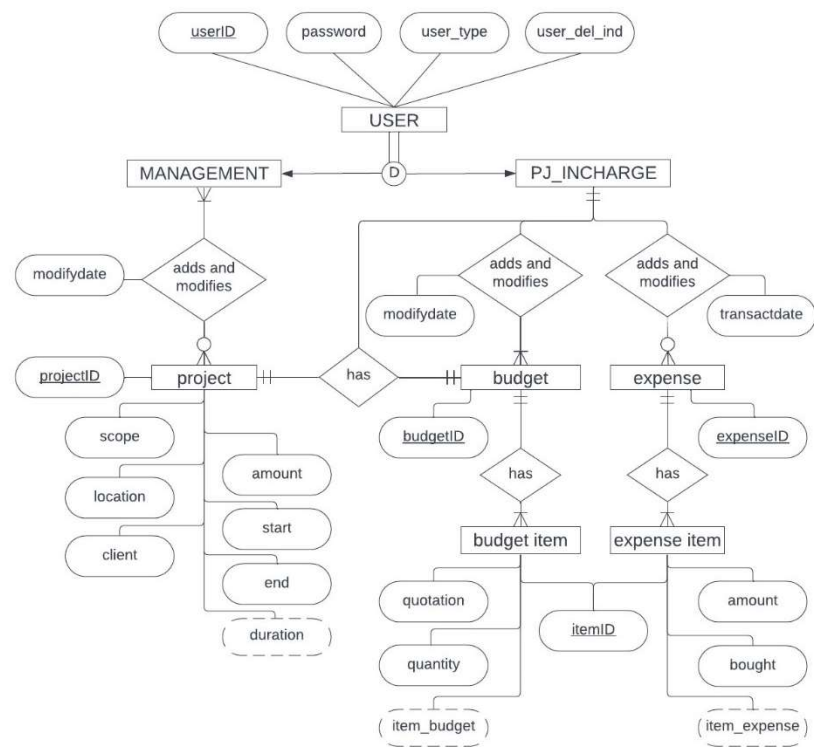
A short detail and sample for each variable is presented in the last section of this report

3. Relational Database Model

III. Appendices

1. Variable Guide

USER – contains information for all user

Name	Description	Sample
userID	Primary key; unique 6-digit id assigned to each account set-up by the application manager	456117
password	Alpha-numeric string set-up by application manager	Random_password++02
user_type	Account type, could either be "manager" or "pj_ic"	manager
user_del_ind	User delete indicator, Boolean defaulted as "false"; indicates whether the account is to be deleted or not	false

PROJECT – contains information for projects

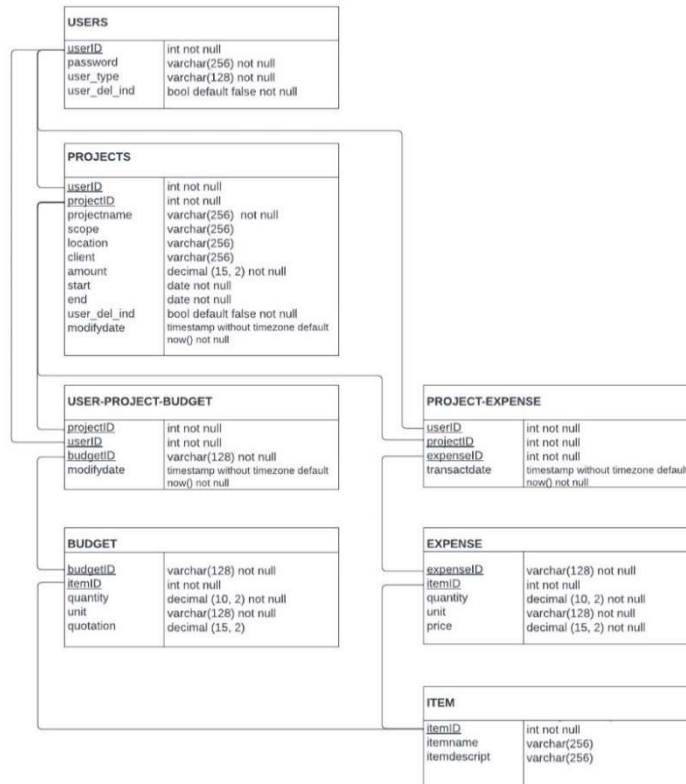| Name	Description	Sample
projectID	Primary key; unique 5-digit id assigned to each project set-up by a manager account	24161
userID	Identifies the project in-charge which could access the project during the report, and add budget and expenses	456117
scope	String for short details/description of the project	Warehouse including roof, columns, foundation, and access road
location	String for project location	Batangas
client	String for client detail (Name, Location, etc.)	Aboxxxx, BGC
amount	Total contract amount of the project including profit	PHP75,000,000.00
start	Official start date of the project	2024-01-01
end	Official project end date of the project	2024-08-30
duration	Duration of the project in months	8
modifydate	Date and time the project was created or last modified	2024-04-29 08:58:00

BUDGET – contains information for budget

Name	Description	Sample
budgetID	Primary key; unique 5-digit id assigned to each budget which automatically matches a project ID.	b-24161
itemID	Unique id assigned to each unique material name	1001
quotation	Quotation or estimated price of an item upon the creation of budget	451.00
quantity	Estimated quantity of the item	8
item_budget	Total budgeted amount of the item obtained by multiplying quotation and quantity	3,608.00
modifydate	Date and time the budget was created or last modified	2024-04-29 08:58:00

EXPENSE– contains information for expenses

Name	Description	Sample
expenseID	Primary key; unique 8-digit id assigned to each expense which automatically matches a project ID.	e-24161-001
itemID	Unique id assigned to each unique item keyword	1001
amount	Actual cost of an item upon purchase	401.00
bought	Actual quantity of the item bought	8
item_expense	Total cost of the item bought obtained by multiplying amount and bought	3,208.00
transactdate	Date and time the expense transaction was recorded	2024-04-29 08:58:00

ITEM– contains information for each item

Name	Description	Sample
itemID	Unique id assigned to each unique material name	1001
itemname	String for short keyword of the item	Ready-Mix Concrete
Itemdescription	String for short details/description of the item	4500 psi, 28-days

2. Attachment Files

GIF Files:
Attachment 1. Loggin-in as TM and PIC
Attachment 2. Adding Project
Attachment 3. Adding Project Budget and Expense
Attachment 3a. Budget Mode – Viewing and Modifying
Attachment 4. Project Overview and Editing a Project

3. App Source Code

https://github.com/josh-rdc/PEARS-dashapp/tree/main

4. References

- Peterson, Steven J. (2020). Construction Accounting and Financial Management. Fourth Edition. Pearson.

- Wiley and Sons. (2008). Commercial Management of Projects: Defining the Discipline.

[1] https://www.oracle.com/ph/erp/project-portfolio-management-cloud